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[73]专利权人 罗光男
地址 中国台湾

[72]设计人 郑文山

[74]专利代理机构 中国专利代理(香港)有限公司
代理人 林长安

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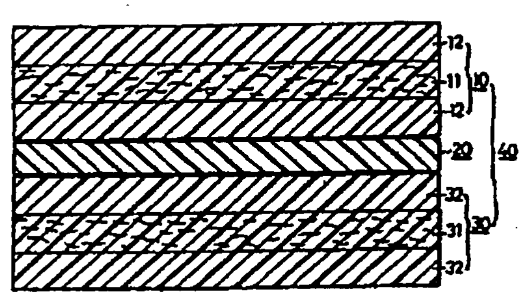
[54]实用新型名称 运动器材的复合材料管状物

[57]摘要

一种运动器材的复合材料管状物，以纤维含浸热固性树脂制成纤维热固性塑胶层，且以具有透孔的热塑性塑胶制成一层热塑性塑胶层，该热塑性塑胶层夹固在上下两层的纤维热固塑胶层中，借助该透孔使上下层纤维热固性塑胶的热固性树脂相互固结密合，而形成具有高强度、降低冲击能力好及避震效果强的复合材料层。



权利要求书

1.一种运动器材的复合材料管状物，具有上、下层的纤维热固性塑胶层，其特征在于：

在该上、下层的纤维热固性塑胶层之间具有一层热塑性塑胶层，而固结形成一复合材料层；

该纤维热固性塑胶层是以至少一层的热固性树脂含浸纤维材料所形成的材料体，而该热塑性塑胶层是以具有高阻尼特性的热塑性塑胶制成具有透孔的材料体，该上、下层的纤维热固性塑胶层透过热塑性塑胶层的透孔互相紧密连结.

2.如权利要求 1 所述的运动器材的复合材料管状物，其特征在于：该热塑性塑胶层是一径向剖面呈整圈环状的封闭型层体。

3.如权利要求 1 所述的运动器材的复合材料管状物，其特征在于：该热塑性塑胶层是径向剖面不是连续的层体，且以预定的间隔搭配有纤维热固性塑胶，该热塑性塑胶层不是整圈封闭的层体。

4.如权利要求 1 所述的运动器材的复合材料管状物，其特征在于：该热塑性塑胶层是使用不织布或孔状编织物、薄膜穿孔材料含浸热塑性塑胶制成表面具有多孔的层体.

说　明　书

运动器材的复合材料管状物

本实用新型涉及一种运动器材的复合材料管状物，特别是涉及一种应用在运动器材上，可达到强度佳、避震效果良好的运动器材的复合材料管状物。

复合材料由于具有量轻质坚的特性，目前普遍受运动器材管状物所应用，例如球拍、高尔夫中管、曲棍球中管及球棒等。而复合材料以热塑性塑胶及热固性树脂两种复合材料最受厂商在制造运动器材上所应用：热塑性塑胶简称 TP，例如以聚乙烯、聚丙烯、聚碳酸酯或尼龙等与纤维材料如炭纤维、玻璃纤维、硼纤维、有机纤维或金属纤维等材料结合形成的纤维强化热塑性塑胶复合材料；热固性树脂简称 TS，例如以不饱合聚酯、环氧树脂或酚－甲醛树脂等与纤维材料结合形成的纤维强化热固性塑胶复合材料。

如图 1 球拍拍框的叠层示意图所示，由于热塑性塑胶与热固性树脂具有很难相互固结一体的特性，所以一般运动器材的复合材料管状物，都是由单一材料所制成，也就是采用纤维强化热塑性塑胶或纤维强化热固性塑胶其中一种为材料层 1，该材料层 1 再依序叠层包覆而形成完整拍框的结构。由于热塑性塑胶为长链状构造的分子集团，通常具有较高的阻尼系数的性质。例如，在纤维强化热塑性塑胶中以最常应用的尼龙 6 与碳纤维所制成的网球拍为例，其阻尼系数约为 0.004，由振动力学的观念可知，其复合材料结构本身振动的消除，主要是由结构中阻尼系数来决定。也就是在受相同外力作用下，结构本身阻尼系数愈大，此种复合材料结构的避震效果愈好。所以，具有较高阻尼系数的纤维强化热塑性塑胶生产的制品，通常可以降低制品

本身受外力作用时所产生的冲击与振动，但是其结构强度远不如纤维强化热固性塑胶的制品，以该材质所制成的拍框本身不能承受太高的网线张力(约 60 磅)，以致在打击时无法获得较佳的控球性。

此外，纤维强化热固性塑胶中，以最常使用的石墨与环氧基树脂所制成的球拍为例，其加工热固成型后会形成为架桥式巨大分子结构，所以纤维强化热固性塑胶生产的制品，通常具有较佳的强度，能承受较高磅数的网线张力(约 80 磅)，但是，以此种材质制成的球拍，其阻尼系数约为 0.002 ，所以纤维强化热固性塑胶阻尼系数约是纤维强化热塑性塑胶的二分之一，在降低结构本身受外力作用时所产生的冲击与振动能力远不如纤维强化热塑性塑胶，让使用者打击球时，必须承受球拍反震的力量，容易产生如“网球肘”的运动伤害。

因此，纤维强化塑性塑胶与纤维强化热固性塑胶单独使用时，分别有其材料特性的优缺点，如何结合两者使运动器材管状物获得更适用的性能，是厂商努力的目标.

本实用新型的目的在于提供一种运动器材的复合材料管状物，是以一层具有透孔的热塑性塑胶层做为中间塑胶层，并且上、下层纤维强化热固性塑胶层相互叠层，该上、下层纤维强化热固性塑胶层的热固性树脂可透过热塑性塑胶层的透孔而互相紧密地固结，而形成具有高强度、吸震效果也很好的复合材料层.

本实用新型运动器材的复合材料管状物，其主要是在上、下层的纤维热固性塑性层中间形成一层热塑性塑胶层，而固结形成复合材料层。该纤维热固性塑胶层是以至少一层的热固性树脂含浸纤维材料所形成的材料体，而该热塑性塑胶层是具有较高阻尼特性的热塑性制成具有透孔的材料体，该上、下层纤维热固性塑胶层的热固性树脂可透过热塑性塑性胶层的透孔，相互紧密地连结，且可使热塑性塑胶层固置在热固性塑胶层内。该纤维热固性塑胶层与热塑性胶层叠层的层数

可依需要作单层或多层叠层的型式，也可依据复合材料管状物避震部位的需求强度上的考虑，该热塑性塑胶层可采取封闭型或开放型的组叠结构，使其具有热塑性塑胶及热固性树脂的特性，使整体具有强度高、吸震良好的优点。

下面通过最佳实施例及附图对本实用新型运动器材的复合材料管状物进行详细说明，附图中：

图 1 是以往球拍拍框的叠层示意图；

图 2 是本实用新型较佳实施例的组合剖面图；

图 3 是本实用新型较佳实施例的结合示意图；

图 4 是本实用新型较佳实施例封闭型叠层示意图；

图 5 是本实用新型较佳实施例开放型叠层示意图；

图 6 是沿图 4 中直线 6-6 的剖面图；

图 7 是沿图 5 中直线 7-7 的剖面图；

图 8 是本实用新型球拍振动实验的示意图；

图 9 是以往网球拍振动实验所测出振动图形；

图 10 是本实用新型网球拍振动实验所测出振动图形。

如图 2 、 3 所示，本实用新型运动器材的复合材料管状物，其主要应用在运动器材圆管状的结构，是在上、下层的纤维热固性塑胶层 10 、 30 之间加入一层的热塑性塑胶层 20，加热固结后整体形成一复合材料层 40 。该上、下层纤维热固性塑胶层 10 、 30 都是以纤维材料 11 、 31 含浸热固性树脂 12 、 32 所形成的材料体，而该热塑性塑层 20 是以具有阻尼系数比热固性树脂高的热塑性塑胶所制成具有透孔 21 的材料体，制作透孔 21 的方式可使用如不织布或孔状編织物、薄膜穿孔等材料含浸热塑性塑胶制成表面具有多孔的层体，借助两纤维热固性塑性层 10 、 30 中间加入热塑性塑胶层 20,上、下纤维热固塑胶层 10 、 30 的热固性树脂 12 、 32 透过该热塑性塑胶层 20 的透

孔 21 而相互紧密连结，形成完整的结构。

以上为本实用新型运动器材的复合材料管状物各构成材料相关构造及位置，本实用新型所运用的技术特点说明如后。

本实用新型是针对管状物制品，适合应用在强度要求高，且必须降低冲击与振动的运动器材的结构上，如球拍、高尔夫中管、曲混球中管、球棒等上。配合图 3 所示，由于本实用新型在纤维材料 11 、31 与热固性树脂 12 、 32 所制成的纤维热固性塑胶层 10 、 30 之间，加入中间材质热塑性塑胶层 20 ，该热塑性塑胶层 20 是采用热塑性塑胶构成整面具有透孔性质的材料，所以经过叠层帛作时，位于热塑性塑胶层 20 上层的上纤维热固性塑胶层 10 ，其热固性树脂 12 就借助该透孔 21 渗透过热塑性塑胶层 20 ，而与位在热塑性塑胶层 20 下层的下纤维热固性塑胶层 30 的热固性树脂 32 紧密地相互连结，上下两层热固性树脂 12 、 32 能够以架桥式巨大分子方式紧密地接合并经加热而维持原有的强度，而且本实用新型所运用的复合材料层 40 中间材质为阻尼系数高于热固性树脂的热塑性塑胶，也具有降低冲击及避震的良好效果。

本实用新型的上、下纤维热固性塑胶层 10 、 30 与热塑性塑胶层 20 叠层的数目可依实际需要，作适当的叠层组合(例如:TS+TP+TS+TP+TS+TP ……,或是 TS+TS+TP+TS+TS+TP+TS+TS 等的组合形式)，以调整运动器材的强度及避震能力。另外，本实用新型也可依据复合材料管状物避震部位的需求及强度上的考虑，管状物热塑性塑胶层 20 组叠方式可采取封闭型或开放型的组叠结构，配合图 4 、 6 所示，为封闭型组叠结构，其是指热塑性塑胶层 20 为一个径向剖面封闭的整圈环状的层体，其避震效果可及整个管状物。另外，配合图 5 、 7 所示是所谓的开放型组叠结构，其是指热塑性塑胶层 20 不是整圈封闭的环体，该热塑性塑胶层 20 径向剖面呈非连续层

体，以预定的间隔搭配有适当区间的热固性树脂 12、 32 使该热塑性塑胶层 20 呈非整圈封闭的层体，而可依特定部位的避震需求而设置。

为进一步证明本实用新型可达到预期功效的要求，以五层纤维强化热固性塑胶层 10 与四层纤维强化热塑性塑胶层 20 的结合为例，估算其阻尼系数。对长纤维的复合材料来说，阻尼系数可以使用下述的公式计算：

$$U_c=(V_{tp}U_{tp}E_{tp}+V_{ts}U_{ts}E_{ts})/E_c$$

其中， U_c 为纤维强化热固性塑胶层 10 及热塑性塑胶层 20 结合后的复合材料层 40 的阻尼系数， U_{tp} 为热塑性塑胶层 20 阻尼系数，而 U_{ts} 为纤维强化热固性塑胶层 10 的阻尼系数， V_{tp} 为热塑性塑胶层 20 的体积含有率， V_{ts} 为纤维中化热固性塑胶层 10 的体积含有率， E_c 为纤维强化热固性塑胶层 10 及热塑性塑胶层 20 结合后的复合材料层 40 的弹性模数， E_{tp} 为热塑性塑胶层 20 的弹性模数，而 E_{ts} 为纤维强化热固性塑胶层 10 的弹性模数。

该复合材料层 40 在此阻尼公式中，纤维强化热固性塑胶层 10 的体积含有率 V_{ts} 约为 0.56(5 层/9 层)，阻尼系数 U_{ts} 公知约为 0.002，弹性模数 E_{ts} 约为 89.17175GPa，可以视为纤维的叠层。热塑性塑胶层 20 其体积含有率 V_{tp} 约为 0.44(4 层/9 层)，阻尼系数 U_{tp} 公知约为 0.004，弹性模数 E_{tp} 约为 89.28GPa,可以视为纤维的叠层。 E_{tp} 与 E_{ts} 数值相差不大，两者结合后的 E_c 也接近此两者的数值，上述公式分子与分母的各 E 值以相同值代入消去后，以本实用新型制成的网球拍最后可得到约为 0.00288 的阻尼系数，在降低冲击与振动的能力上，明显优于纤维强化热固性树脂,阻尼系数增加约 0.00088,改善避震能力约 44%,可减少因使用运动器具而发生运动伤害的机率。

为了确实证明本实用新型具有良好的避震效果及降低冲击的能力，以一网球拍振动试验测试其结果，将该试验评述如下：

配合图 8 所示，此球拍振动试验是将球拍 50 的拍柄 51 固定在一个夹具 52 上，再以一敲击物 53 捶击球拍 50 网面 54 ，并在拍柄 51 上装有一个加速度侦测器 55 ，以感应震动波，经电脑绘图仪将其振动波形绘出，以测知其振动幅度的大小。影响振动试验有以下的因素:

(1)夹具 52： 夹具 52 相当于给予网球拍 50 束缚，松紧度对试验的结果影响很大，为了试验过程让边界条件一致，所以使用扭力扳手控制夹具 52 的松紧度.

(2)敲击物 53： 为了使试验与实际情况近似，使用网球作为敲击物，放置于固定高度后自由落下，撞击网球拍 50 。

(3)加速度侦测器 55： 加速度侦测器 55 大小影响接受的灵敏度，本实验中以较小型的 540-N 感应器进行测试.

本试验是对以往网球拍(纤维强化热固性树脂)与以本实用新型的网球拍施以相同的力量测试，并记录其振图形，振动图形激震(最大振幅)较大，让使用者受到的冲击力则愈大，最容易产生运动伤害，而余震(激震以后的振幅)时间较长的，其避震效果不良，让使用者受到振动力的时间更久，容易造成使用者肢体酸麻。经过试验后测试的结果，以往网球拍的振动图形如图 9 所示，而以本实用新型的网球拍则如图 10 所示，以试验结果可归纳出以下的结果:

(1)振动幅度: 由试验图形可明显看出以往网球拍最大振动幅度 103 毫伏特，约为以本实用新型制成的网球拍 67 毫伏特的 1.5 倍，因此本实用新型在避免冲击的能力上比以往网球拍好.

(2)振动衰减: 由试验图形可看出以往网球拍振动衰减一半所需时间约 87.6 毫秒，本实用新型振动衰减一半所需时间约 22.4 毫秒，以往网球拍的比值约为本实用新型网球拍的 4.0 倍，因此以本实用新型制成的网球拍在避免振动的能力上比以往的网球拍好。

由测试的试验数据可以分辨出以本实用新型制成的网球拍无论在避免冲击与振动能力上都比以往网球拍好，所以，本实用新型对于防止运动伤害发生，比以往网球拍(纤维强化热固性树脂)有效。

综上所述，本实用新型运动器材的复合材料管状物应用具有透孔的热塑性塑胶层，使上下两热固性树脂层透过该透孔而连结的特有结合技术，可将热固性树脂及热塑性塑胶紧密地贴合，由此材质所制成的复合材料可兼具以上两种材质的优点，具有强度高、降低冲击能力及具有良好的避震效果。

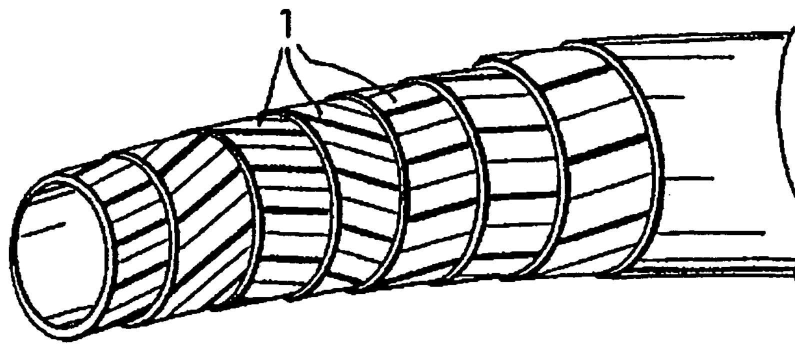


图 1

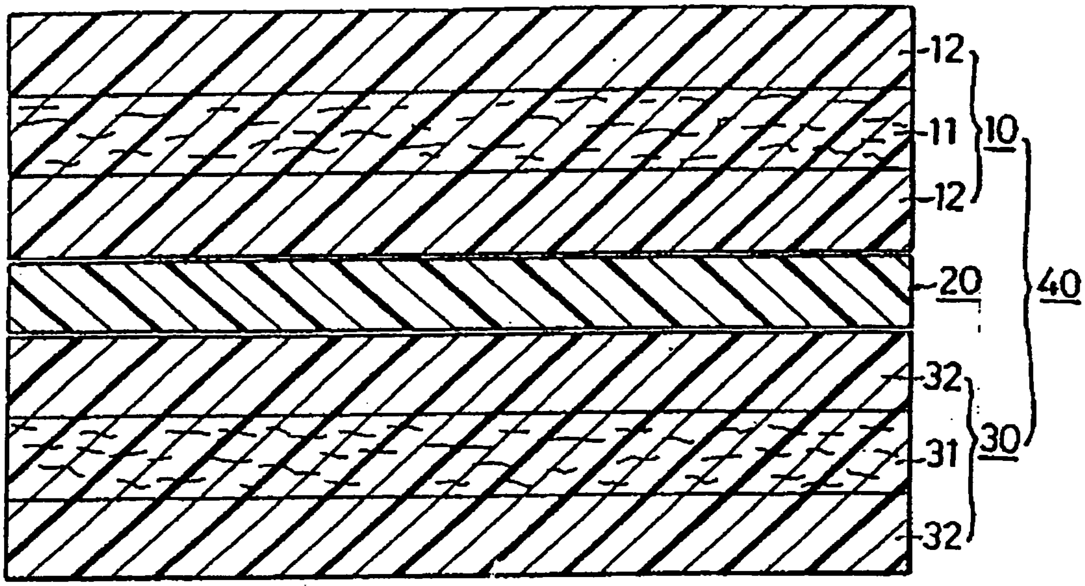


图 2

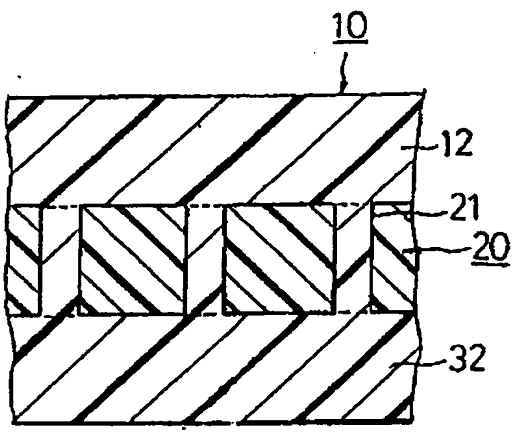


图 3

图 4

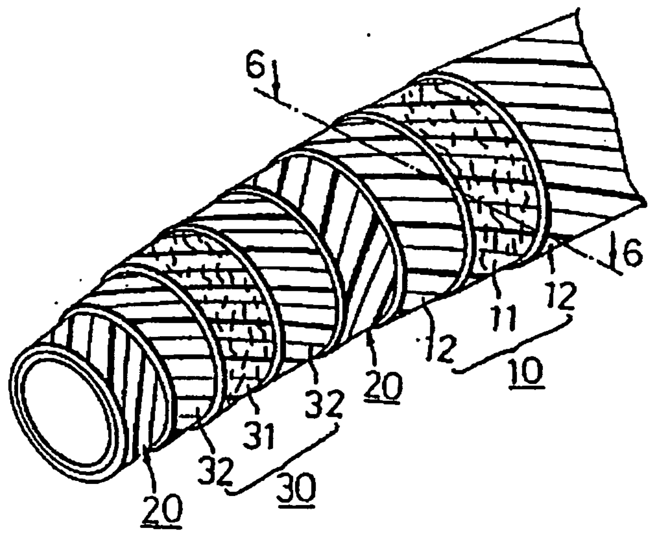
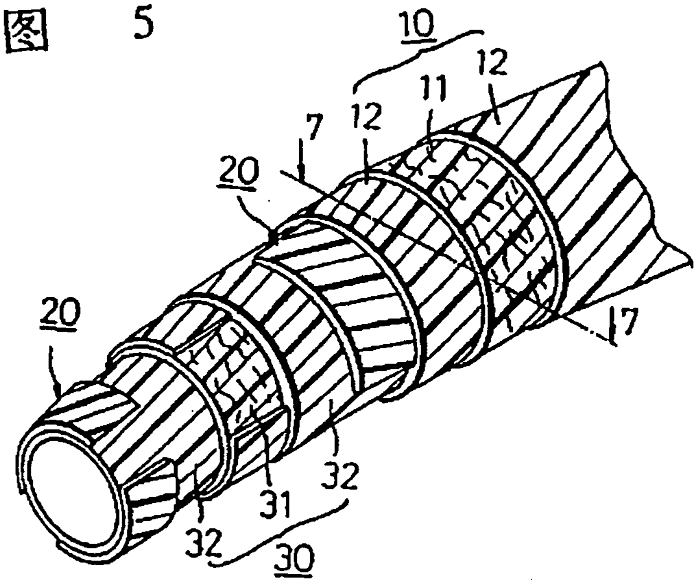


图 5



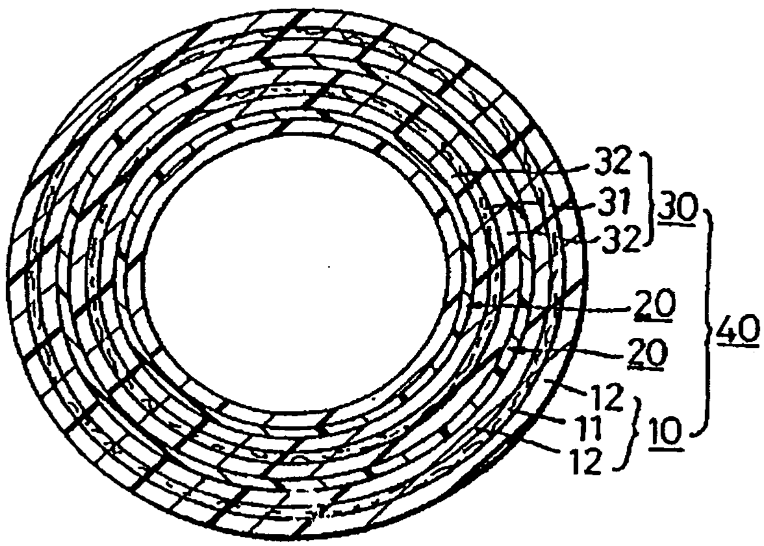


图 6

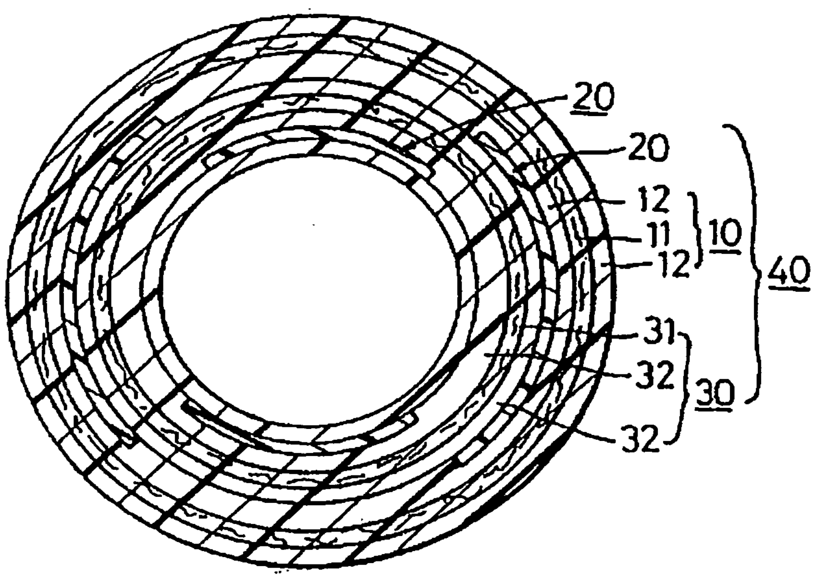


图 7

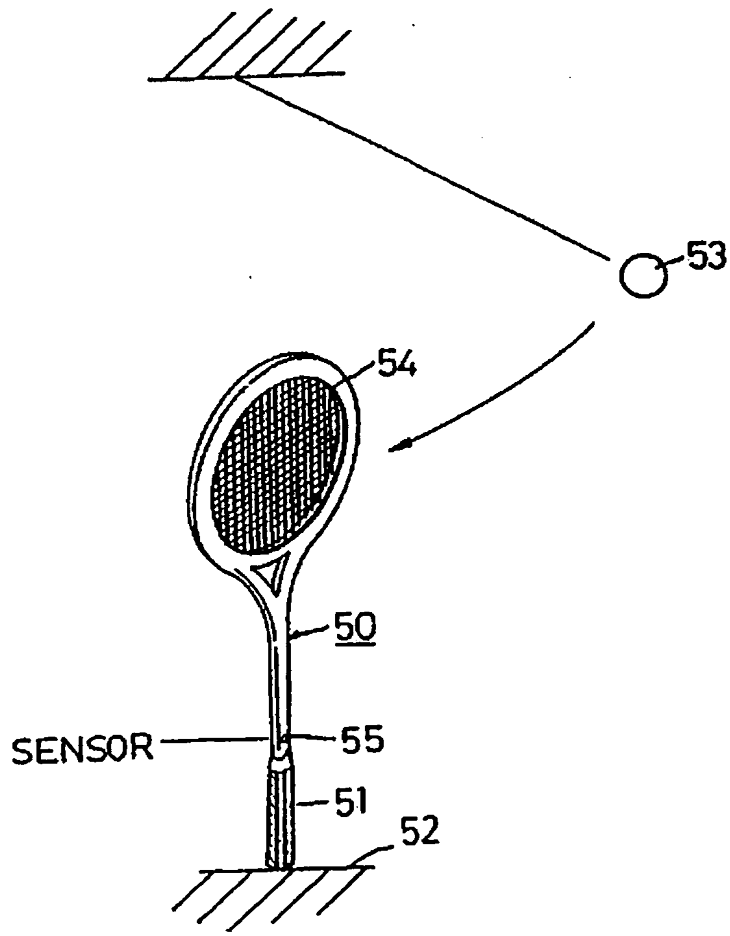


图 8

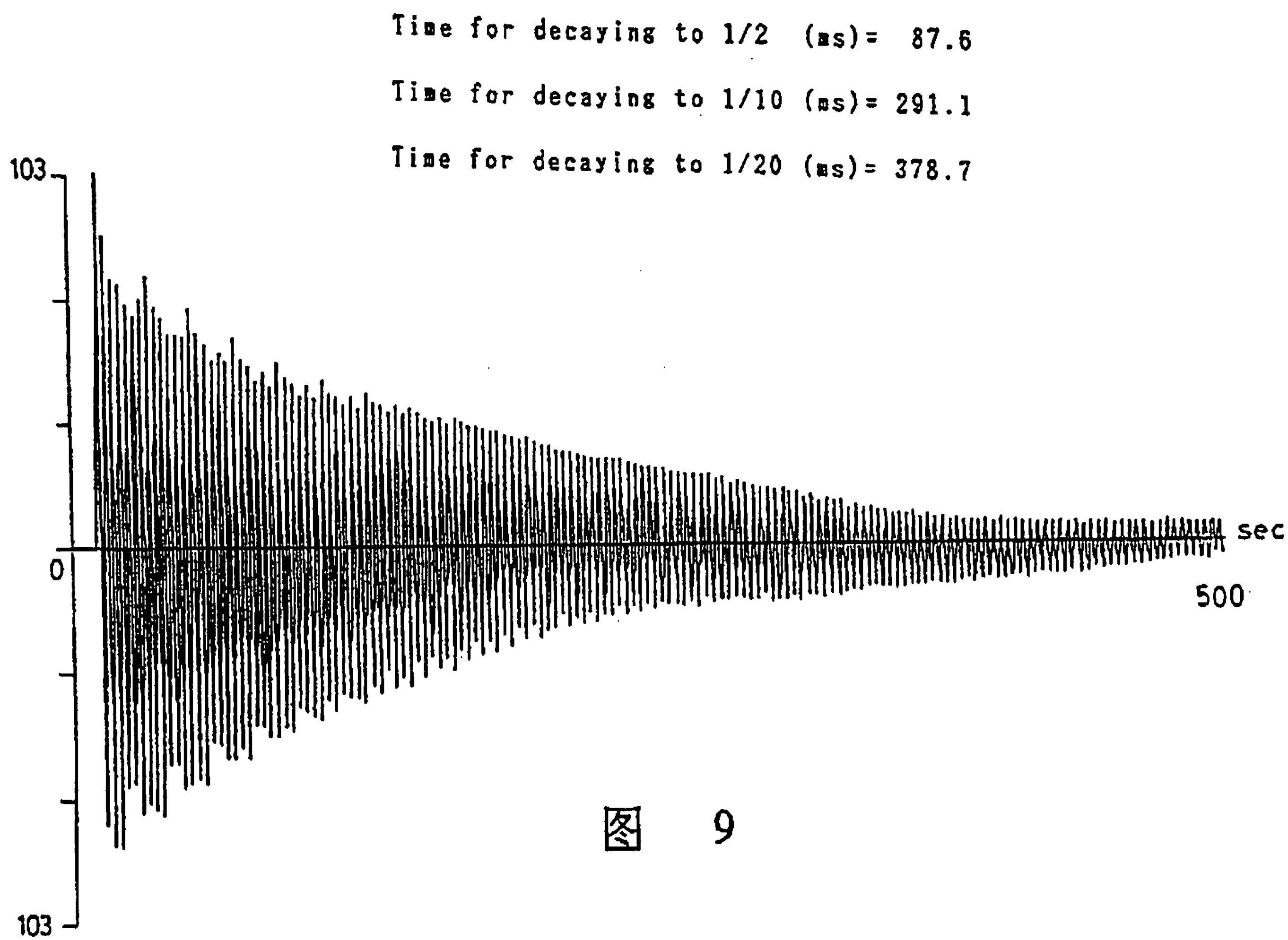
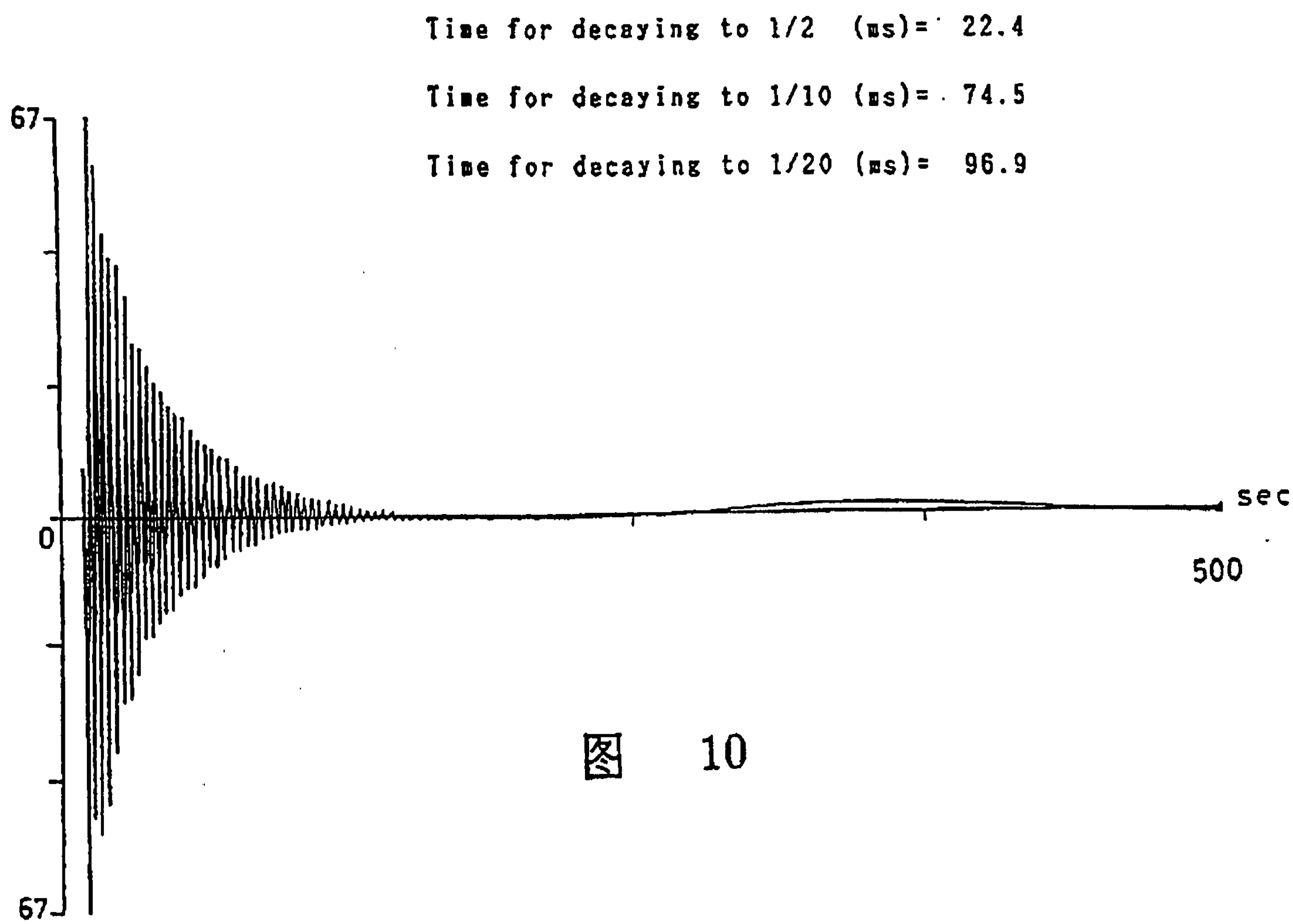

Time for decaying to 1/2 (ms)= 87.6
Time for decaying to 1/10 (ms)= 291.1
Time for decaying to 1/20 (ms)= 378.7
103
0
103
sec
500

图 9



Time for decaying to 1/2 (ms)= 22.4
Time for decaying to 1/10 (ms)= 74.5
Time for decaying to 1/20 (ms)= 96.9
67
0
67
sec
500

图 10

Composite material tubular article for sports apparatus

Patent number:	CN2239883Y
Publication date:	1996-11-13
Inventor:	WENSHAN ZHENG (CN)
Applicant:	LUO GUANGNAN (CN)
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Translation of cited Ref. 1

Composite material tubular article for sports apparatus

This new utility model involves a kind of composite material tubular article for sports apparatus, particularly involves a kind of a composite material tubular article applied on the sports apparatus, that can make the sports apparatus have good strength and anti-vibration effect.

Because the composite material has the characteristics of light mass and tough quality, it is popularly applied by the tubular article forsports apparatuses, for example rackets, middle tube of golf and hockey, and bats. For the composite material, thermoplastic and thermoset are two kinds of composite materials mostly welcomed by factories making sports apparatuses: the thermoplastic is abbreviated as TP, which is a fiber reinforced thermoplastic composite material formed, for example, by combining polyethylene, polypropylene, polycarbonate or nylon with fiber material, such as carbon fiber, glass fiber, boron fiber, organic fiber or metal fiber; the thermoset is abbreviated as TS, which is a fiber reinforced thermoset composite material that is formed, for example, by combining unsaturated polyester, epoxy resin or phenol - formaldehyde resin with fiber material.

As shown by the stack indicating graph of the racket frame in Figure 1, due to the thermoplastic and the thermoset have the characteristics of very difficult in fixing into one entity, the composite material tubular article of general sports apparatuses is made of single material. That is, utilizing fiber reinforced thermoplastic or fiber reinforced thermoset as material layer 1. The material layer 1 is then stacked in sequence to form integrated structure of a racket. Since thermoplastic is long chain configured molecular radical, it generally has the property of higher damping coefficient. For example, the most commonly used nylon 6 in the fiber reinforced thermoplastic for example, it forms tennis racket with carbon fiber for instance, its damping coefficient is approximately 0.004. It is known from the viewpoints of vibration kinetics that the elimination of vibration of its composite material structure is mainly determined by the damping coefficient of the structure. That is, while be subjected to the same external force action, the larger the damping coefficient of the structure, the better anti-vibration effect of this composite material structure. So, article made by fiber reinforced thermoplastic having higher damping coefficient generally can reduce the resulted impact and vibration while it is subjected to the external force, but its structure strength is far inferior to article made of fiber reinforcedthermoset. The racket frame made of this material cannot bear too high net line tension (about 60 pounds), such that it cannot acquire better controllability when hitting.

In addition, for the fiber reinforced thermoset, take the most commonly used graphite and epoxy resin formed bat as an example, it will form bridging type macromolecular structure after a process of heat curing formation （加工热固成型）, so the articles made of fiber reinforced thermoset usually have better strength, can bear higher net line tension (about 80 pounds) , but the damping coefficient of the bat made from this kind of material is about 0.002. Therefore, the damping coefficient of fiber reinforced thermoset is 1/2 of that of fiber reinforced thermoplastic and the ability of lowering the impact and the vibration produced when the structure subjected to the external force are far inferior to the fiber reinforced thermoplastic, so it let the user must bear the re-bounce force of the racket. It readily causes sport injuries of "tennis elbow" for instance.

Accordingly, when the fiber reinforced thermoplastic and fiber reinforced thermoset are used alone, each have the merit and shortcoming of the material characteristics . It is factory's diligent target in how to combine both to make the tubular article for sports apparatus obtaining more applicable property.

The purpose of this new utility model is to provide a kind of composite material tubular article for sports apparatus, which used a layer thermoplastic having permeable apertures as the middle layer, and both the upper and the lower fiber reinforced thermoset layer stack with each other. Both the upper and the bottom fiber reinforced thermoset layers can joint closely together through the permeable apertures of the thermoplastic layer, thereby form composite material layer with high strength and vibration absorption effect.

The present composite material tubular article for new type sports apparatus mainly forms a thermoplastic layer between the upper and lower fiber thermoset layers, thereby fixed to form composite material layer. The fiber thermosetlayer is a material body formed from at least on layer of fiber material impregnated with thermoset, while the thermoplastic layer is the material body with permeable aperture that made of thermoplastic having higher damping characteristics. The thermoset of the upper and lower fiber thermosetlayer can go through the permeable apertures of the thermoplastic layer and joint closely with each other and can allow the thermoplastic layer fixed inside the thermoset layers. The number of layers that fiber thermoset layer and the thermoplastic layer stack together may depend on needs and act as single layer or multi layer form, and also may depend on the consideration of the needs in strength of anti-vibration part of the composite material tubular article. The thermoplastic layer may adopt a stack structure in closed form or semi-open form, thereby allow it having the characteristics of thermoplastic and thermoset and making the overall has the advantages of high strength and good vibration absorption.

The new utility of the composite material tubular article for sports apparatus is exemplified in detail by the following embodiments and figures, wherein:

Figure 1 is a indicating graph of stack of former racket frame;

Figure 2 is an assembly cross section graph of the better embodiment of the present new utility model;

Figure 3 is a combined sketch graph of the better embodiment of the present new utility model;

Figure 4 is an indicating graph of the closed type stack of the better embodiment of the present new utility model;

Figure 5 is an indicating graph of the open type better embodiment the present new utility model;

Figure 6 is the section graph along the straight lines 6-6 in Figure 4;

Figure 7 is the section graph along the straight lines 7-7 in Figure 5;

Figure 8 is the indicating graph of racket vibration experiment of this new utility model ;

Figure 9 is the vibration pattern determined from vibration experiment of former tennis racket ;

Figure 10 is the vibration pattern determined from the tennis racket vibration experiment of the new utility model .

As shown in Figure 2 and 3, the composite material tubular article of the present new utility model is mainly applied on the pipe shaped structure of sports apparatus, which is adding one layer of thermoplastic layer 20 in between the upper and lower fibrous thermoset layer 10 and 30, forming a composite material layer after heating fixation. The upper and lower fibrous thermoset layer 10 and 30 are both material body formed by impregnating fibrous material 11 and 31 with thermoset 12 and 32, where the thermoplastic layer 20 is the material body with permeable aperture 20 made by thermoplastic having higher damping coefficient than thermoset. The manner of producing permeable aperture 20 includes using materials such as non-woven cloth or pore form fabric, film poring (薄膜穿孔) containing impregnated thermoplastic, forming layer body with multiple pores. By adding thermoplastic layer 20 into fibrous thermoset layer 10 and 30. The thermoset 12 and 32 of the upper and lower fibrous thermoset layer 10 and 30 penetrate through the permeable aperture 21 of this thermoplastic layer 20 and connect closely with each together, thereby form integral structure.

The above is the relating configuration and position of each composition material of the composite material tubular article for sports apparatus of the present new utility model.The application technical features of the present new utility model are explained hereafter.

The present new utility model aims at tubular article, which is suitable for application on structures of the sports apparatuses that demand high strength, must lower the impact and vibration, such as rackets, middle pipe of golf, middle pipe of cricket, bat and etc. In alliance with that is shown in Figure 3, since the present utility model adds the middle material thermoplastic layer 20 in between the fibrous thermoset layer 10 and 30 made of fibrous material 11, 13 and thermoset 12, 32. The thermoplastic layer 20 employs thermoplastic to constitute the material having permeable apertures on the whole surface, so after have been 叠层帛作, the fibrous thermoset layer 10 located on the upper layer of the thermoplastic layer 20 has its thermoset 12 penetrate through thermoplastic layer 20 by dint of the permeable aperture 21, and closely connect with the thermoset 32 of lower fibrous thermoset layer 30 located a the lower thermoplastic layer 20. Both of the upper and lower thermoset 12, 32 are able to connect closely together in the form of bridging type macromolecules and maintain its original strength after heating. Further, the composite material layer 40 middle material applied by the present new utility model is thermoplastic with damping coefficient higher than that of the thermoset, and good effect of lowered impact and anti-vibration.

The number of layers of the upper and lower fibrous thermoset layer 10, 30 and thermoplastic layer 20 of the present new utility model can make suitable stack combination depending on practical needs (for example: the combination form of TS+TP+TS+TP+TS+TP... or TS+TS+TP+TS+TS+TP+TS+TS etc.), so as to adjust the strength and anti-vibration ability of sports apparatuses. Moreover, this present new utility model can also depends on the needs of the anti-vibration part of the composite material tubular articular and the consideration about strength. The stack form of the tubular article thermoplastic layer 20 may apply closed type or semi-open type stack structure, conjugate with what is shown in Figure 4 and 6, it is closed type stack structure, which indicates the thermoplastic layer 20 is a whole circular layer body closed in longitudinal direction. Its anti-vibration effect is comparable with the whole tubular article. Further, what is shown in Figure 5, 7, is the so-called open type stack structure, which indicates that the thermoplastic layer 20 is not a whole circular open type ring body. The longitudinal section of the thermoplastic layer 20 appears discrete layer body, which collocate with with appropriate range of thermoset 12, 32at predetermined space. . It allows the thermoplastic layer 20 to be a non-whole-circular closed layer body and can set according to the anti-vibration needs of specific parts.

To further demonstrate that the present new utility model can reach predetermined requirements of expected effects, a combination of five layers of fiber reinforced thermoset layer 10 with four layers of fiber reinforced thermoplastic layer 20 is taking as a example, in which it's damping coefficient is estimated. For the composite material with long fibers, the damping coefficient can be calculated by the following formula:

$$U_c = (V_{tp}U_{tp}E_{tp} + V_{ts}U_{ts}E_{ts}) / E_c$$

wherein the U_c is the damping coefficient of the composite material layer 40 formed from the fiber reinforced thermoset layer 10 and the fiber reinforced thermoplastic layer 20, U_{tp} is the damping coefficient of the thermoplastic layer 20, while U_{ts} is the damping coefficient of thermoset layer 10, V_{tp} is volume containing rate (体积含有率) of the thermoplastic layer 10, E_c is the elastic modulus of the composite material layer 40 formed by combining fiber reinforced thermoset layer 10 and thermoplastic layer 20, E_{tp} is the elastic modulus of the thermoplastic layer 20, and E_{ts} is the elastic modulus of fiber reinforced thermoset layer 10 .

The composite material, of which the volume containing rate V_{tp} is about 0.56 (5 layers/9 layers), the damping coefficient U_{ts} is known to be about 0.002, the elastic modulus E_{ts} is about 89.17175 GPa in the formula, can be regarded as a stack of fibers. The thermoplastic layer 20, of which the volume containing rate V_{tp} is about 0.44 (4 layers/9 layers), the damping coefficient U_{tp} is known to be about 0.004, the elastic modulus E_{tp} is about 89.28 GPa in the formula, can be regarded as a stack of fibers. The values of E_{tp} and E_{ts} differ not much, and E_c from the combination of these two also close to both values. When each E value in the numerator and in the denominator in the above formula is substituted and eliminated, the final damping coefficient that may be obtained from the tennis racket made from the present utility model is about 0.00288. For the ability in reducing impact and vibration, it is significantly better than that from the fiber reinforced thermoset, in which the damping coefficient is increased by about 0.00088, the anti-vibration ability is improved by about 44%, thereby reduce the probability of sports injuries due to the use of sports apparatuses.

In order to surely demonstrate that the present new utility model has better anti-vibration effect and reduced anti-impact ability, a tennis racket vibration experiment is used to test the results. The experiment is commented as below:

In alliance with the indications in Figure 8, the racket vibration experiment contains: fixing the racket handle 51 of racket 50 in fixture 52, then utilizing a knocking object 53 to knock the net surface 54 of the racket 50, and install a acceleration detector 55 on the racket handle 51 to sense the vibration wave, draw the vibration wave profile by a computer plotter so as to determine the size of its vibration amplitude. Below are the factors that affect the vibration experiment:

(1) Fixture 52: Fixture 52 equals to give the tennis racket 50 binds, the degree of tightness affects greatly to the result of the test. In order to make the peripheral conditions consistent, the torsion spanner is used to control the degree of tightness of fixture 52.

(2) Knocking abject 53: In order to make the test resembling to the actual circumstance, a tennis ball is used as the knocking object. It is placed at a fix height and allowed free falling and knock on the tennis racket 50.

(3) The acceleration detector 55: The size of the acceleration detector 55 influences acceptation of sensibility. In this experiment, smaller typed 540-N sensor is used in the test.

The present experiment uses a same force to test the former tennis racket (the fiber reinforced thermoset) and the tennis racket of this new utility model, and record a vibration profile thereof. Larger the excited vibration (maximum vibration amplitude) of the vibration profile, higher the impact subjected to the user, and it most readily produces sports injuries. For those with longer remaining vibration time (the vibration amplitude after the excited vibration), the effect of their anti-vibration is not good, which make users subjected to vibration for a longer time, readily make the user aching and torpor in limbs. For the test result of the vibration profile of former tennis rackets is shown in Figure 9, while that of the present new utility model is shown in Figure 10. The test results can be summed up as below:

(1)Vibrate amplitude: It is clearly seen from the test pattern that the vibration amplitude of the former tennis racket is 103 mV, which is about 1.5 folds of the 67 mV of the tennis racket of the present new utility model. Hence, the present new utility model is better than the former tennis rackets in the ability of avoiding impact.

(2)Vibrate attenuation: It is seen from the test pattern that the time required for the vibration of the former tennis racket to be decayed to half is about 87.6 milliseconds, while that of the present new utility model is about 22.4 milliseconds. The value of the former tennis racket is 4.0 times of that of the present new utility model. Therefore, the tennis racket made of the present new utility model is better than the former tennis racket in the ability of avoiding vibration.

It can be distinguished from the tested experimental data that the tennis racket of the present new utility model is better than the former tennis racket no matter at the ability of avoiding impact or vibration. Accordingly, present new utility model is more efficient than the former tennis racket in prevention of the occurrence of sports injuries.

In summary,the present new utility of composite material tubular article for sports apparatus applying thermoplastic layer having permeable apertures makes the peculiar binding technique of connecting the upper and lower thermoset layers by the permeable apertures can make the thermoset and the thermoplastic closely joint together. The composite material made from thereof can have the advantages of both material, i.e. high strength, ability of reducing impact and good anti-vibration effect.

Claims

1. A composite material tubular article for sports apparatus, having upper and lower thermosetting plastic layer, characterized in that:

There has a layer of thermoplastics layer in between the upper and lower layers of thermosetting plastic layer;

The thermosetting plastic layer is a material body formed from at least one layer of fibrous material impregnated with thermoset, and the thermoplastic layer is a material body with permeable apertures made of thermoplastic layer having high damping coefficient;

The upper and lower thermoset layers connect closely with each other through the permeable apertures of the thermoplastic layer.

2. The composite material tubular article for sports apparatus according to Claim 1, characterized in that the thermoplastic layer is a closed type layer body having a longitudinal section in whole circular form.

3. The composite material tubular article for sports apparatus according to Claim 1, characterized in that the thermoplastic layer is a layer body that is discrete in longitudinal section, and it collocates with fibrous thermoset at predetermined space, wherein the thermoplastic layer is not a whole circle closed layer body.

4. The composite material tubular article for sports apparatus according to Claim 1, characterized in that the thermoplastic layer uses non-woven cloth or pore form fabric, film pore material impregnated with thermoplastics forming layer body with multiple pores.

Abstract

A composite material tubular article, which uses fiber impregnated with thermoset to make thermoset layer and uses thermoplastic layer with permeable apertures to make a layer of thermoplastic layer. The thermoplastic layer is sandwiched between upper and lower layers of thermoset layers, and the thermoset resin of the upper and lower fibrous thermoset are closely connected with each other by the help of permeable apertures thereon, thereby it forms a composite material with high strength, ability of reducing impact and strong anti-vibration effect.

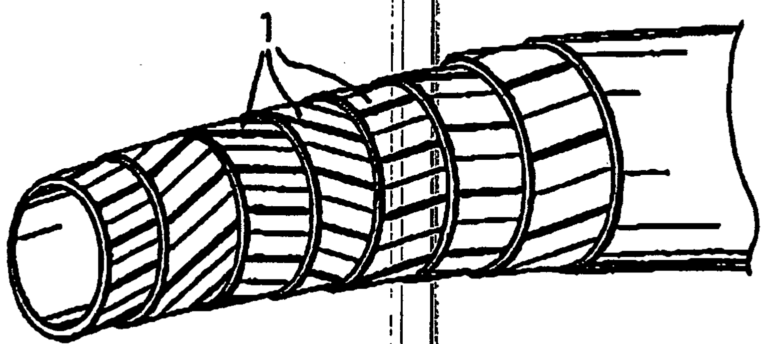


Figure 1

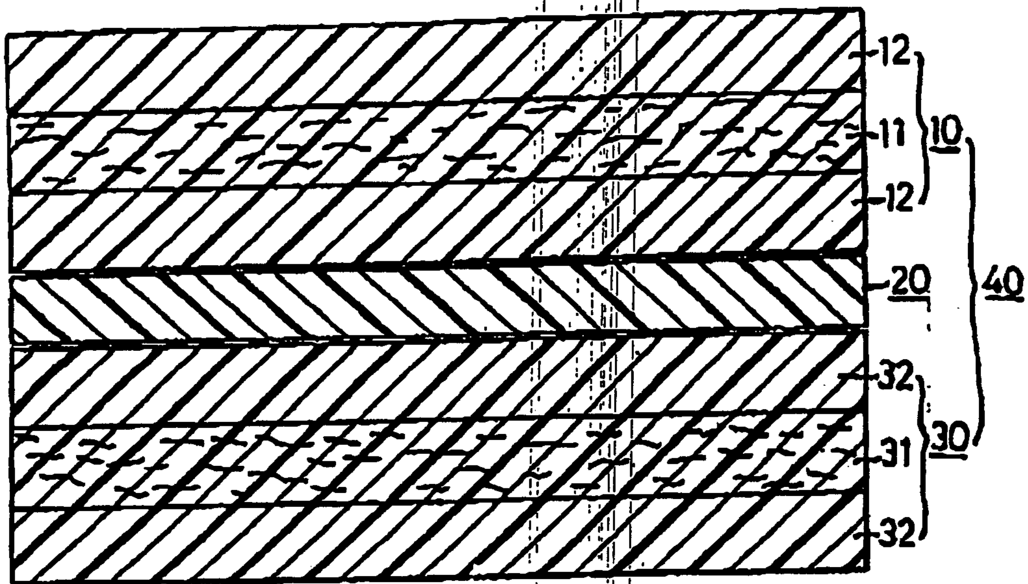


Figure 2

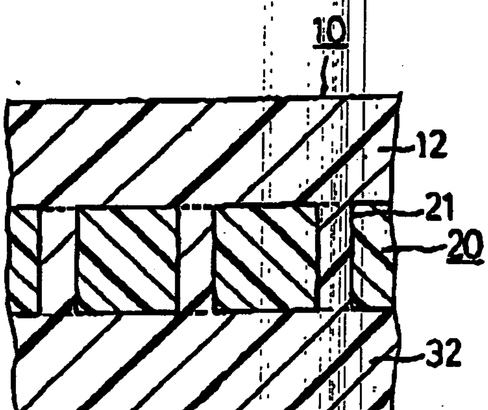


Figure 3

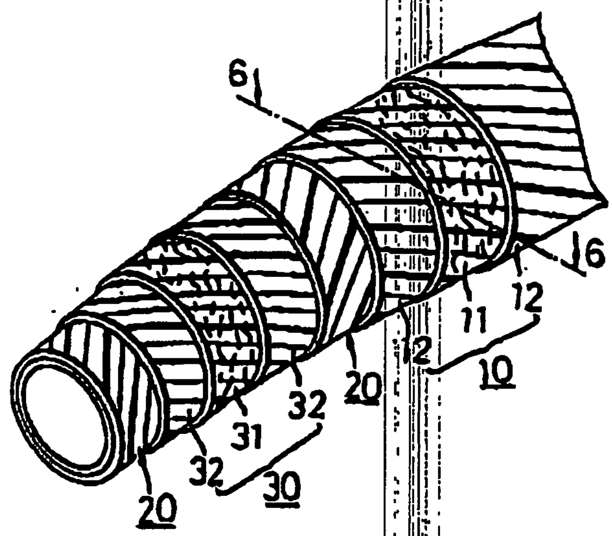


Figure 4

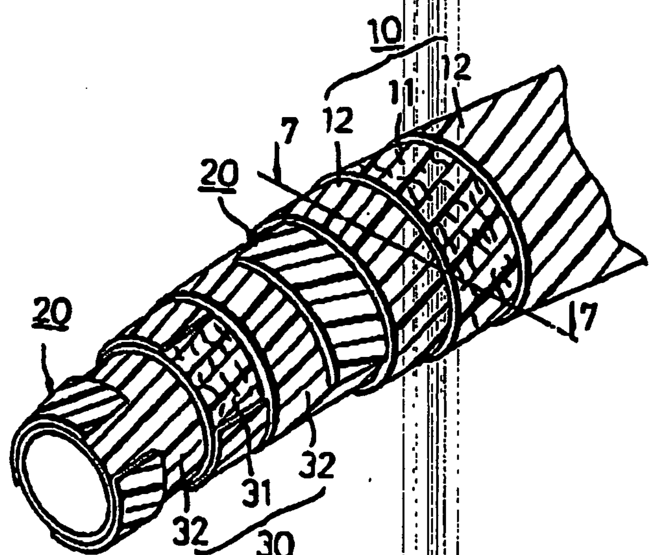


Figure 5

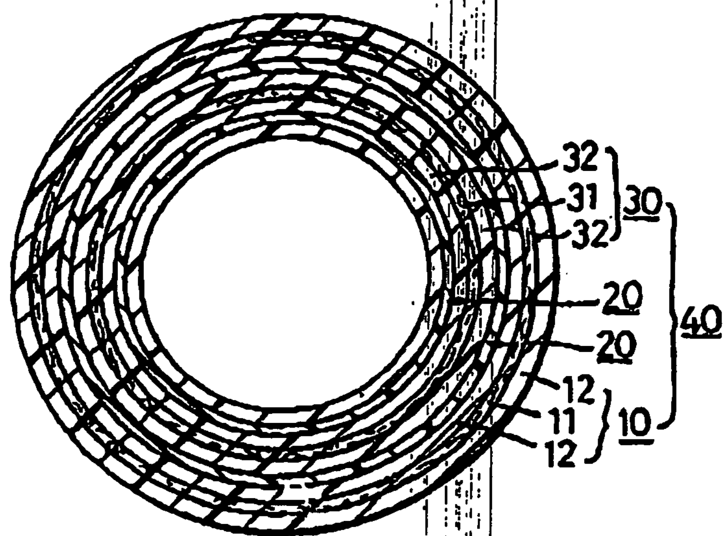


Figure 6

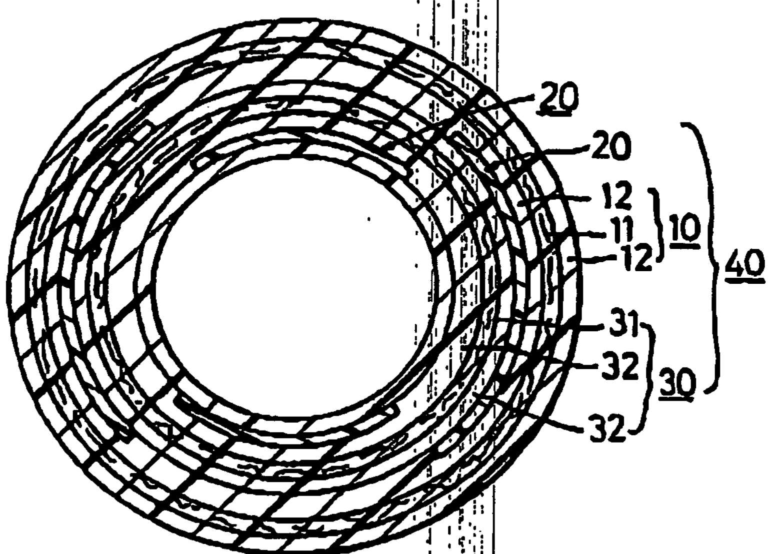


Figure 7

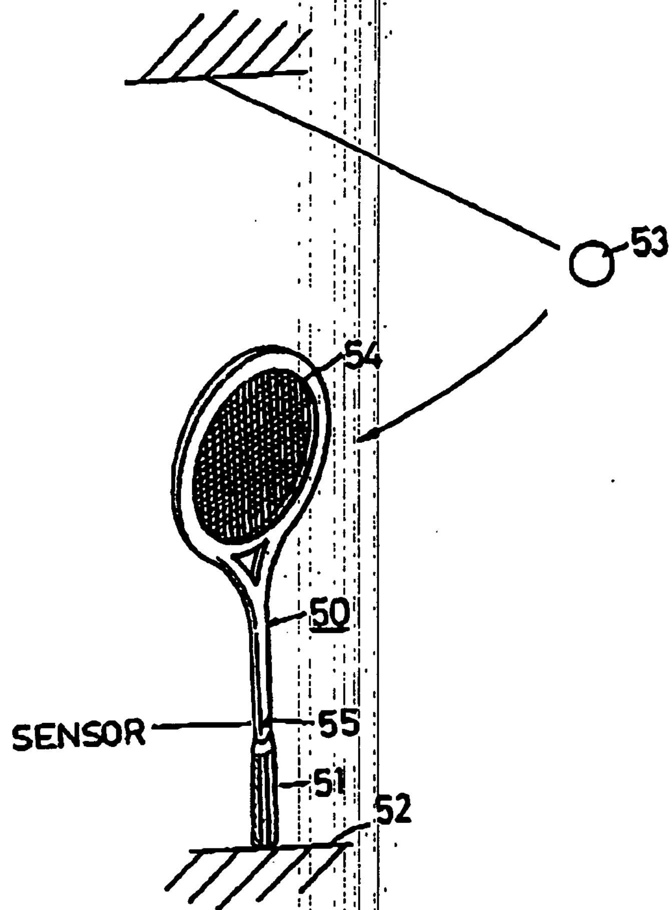
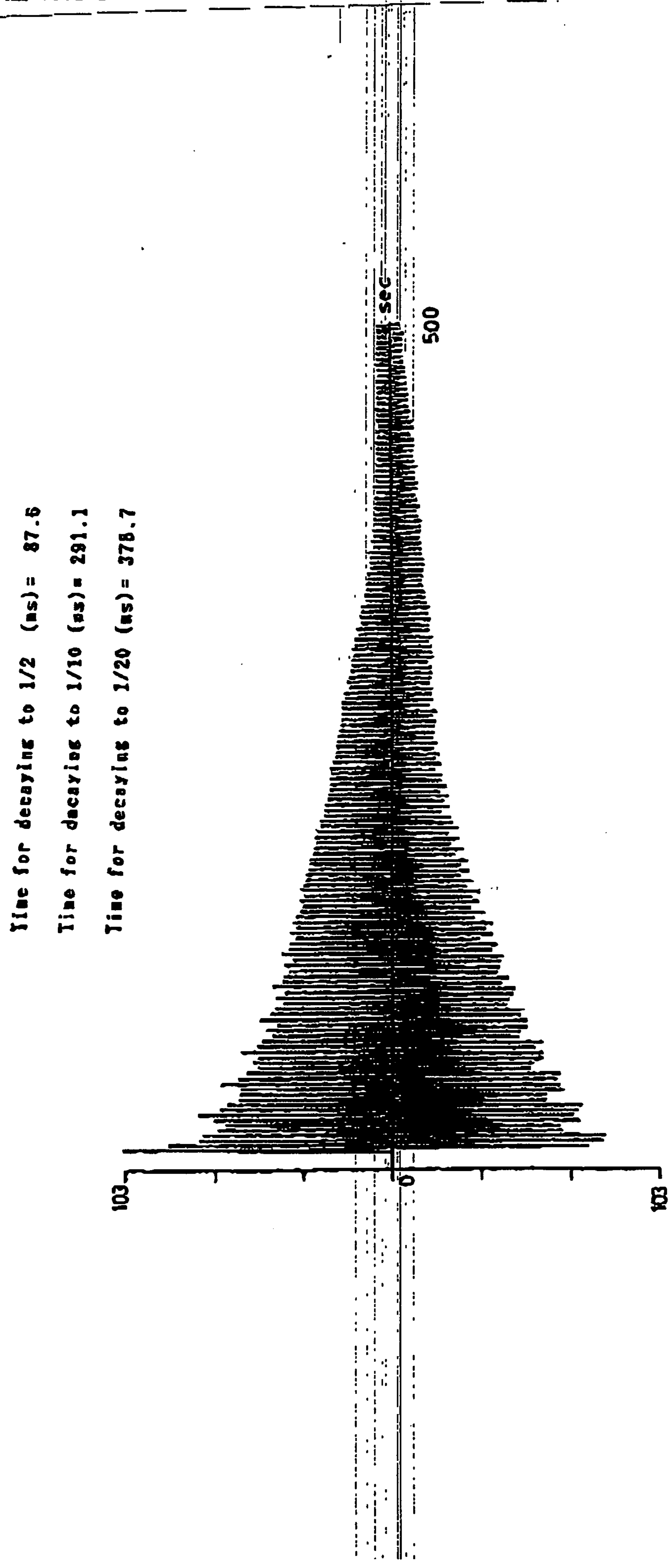


Figure 8



Time for decaying to 1/2 (ms)= 87.5
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Time for decaying to 1/20 (ms)= 375.7
500
sec
103
0
103

Figure 9

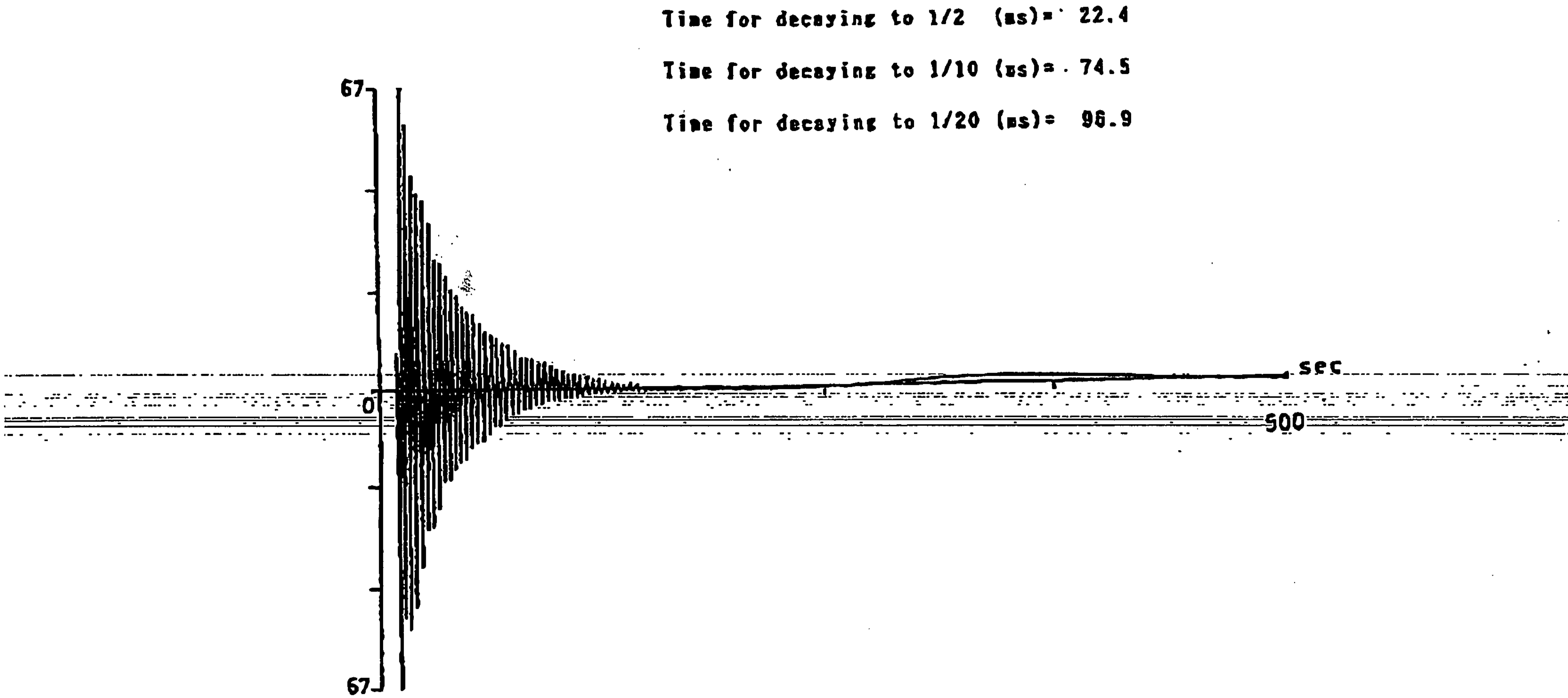
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Figure 10